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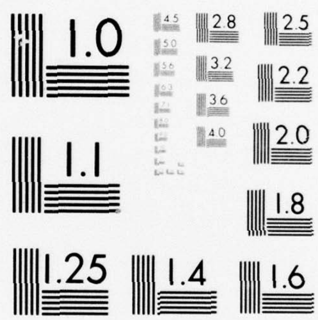

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DCIEM Technical Report No. 77X13

PARKA EVALUATION ON KOOL STOOL II

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L.D. Reed

DEFENCE AND CIVIL INSTITUTE OF ENVIRONMENTAL MEDICINE
INSTITUT MILITAIRE ET CIVIL DE MEDECINE DE L'ENVIRONNEMENT

DEPARTMENT OF NATIONAL DEFENCE — CANADA

March, 1977 DCIEM Technical Report No. 77X13

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PARKA EVALUATION ON KOOL STOOL II

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See 1473

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ABSTRACT

A new Canadian Forces parka (74 Pattern, NSN 8415-21-870-5571) was compared to two other parkas (51 Pattern, NSN 8415-21-103-8127 and 71 Pattern NSN 8415-21-859-6306) in a test in which a quantitative determination was made of their thermal insulation characteristics. Six Canadian soldiers were used as subjects in this test in which measurements were made of rectal and skin temperatures during each subject exposure as well as the temperatures on the interior and exterior layers of the parkas. It was found that the 74 parka was the warmest of the three types while the subjects were standing at rest or walking. However, the increase of energy expenditure during the act of walking was greater in the case of the 74 parka because of its longer length. Furthermore, the heat associated with this energy expenditure was not eliminated as readily as in the 51 parka. It is therefore suggested that the 74 parka be modified by decreasing its length.

INTRODUCTION

A new Canadian Forces Parka (74 Pattern, NSN 8415-21-870-5571) has recently been added to the Canadian Armed Forces clothing stores for use in cold climates. Subjective evaluations of comfort, protection and suitability of military clothing depend on such variables as training and climatic exposure of the personnel involved and are therefore of little value in clothing comparisons. In order to quantitatively determine the suitability of this new parka in the Arctic, a quantitative measurement of its insulation value was made during DCIEM Exercise Kool Stool II (Jan-Feb 1976), at Churchill, Manitoba. Similar assessments were also conducted on two standard Arctic parkas (51 Pattern NSN 8415-21-103-8127 and 71 Pattern NSN 8415-21-859-6306). This report describes the tests and the comparison of the three parka types.

METHODS

Six young male Caucasian Canadian soldiers were used as subjects for these evaluations. Because of limited availability of parkas on Exercise Kool Stool II, each subject did not wear all the parka types in their exposures. Six subjects were tested in all 3 parkas; whereas four were tested only in types 51 and 71.

In each experiment, each subject donned thermal underwear, combat pants, windproof pants, heavy stocks, duffle socks, mukluks, combat shirt, Arctic mitts and liners, balaclava and a test parka. The thermal underwear had thermistors sewn on the interior at the neck (T_1), arm (T_2), wrist (T_3), ankle (T_4), calf (T_5), thigh (T_6), and abdomen (T_7), so that the mean microclimate at the skin could be measured. Each subject also had a rectal thermistor inserted 15 cm into his rectum, for measurement of body core temperature.

After dressing, the subjects left the test laboratory and buildings and stood outside at an ambient temperature which varied between -28°C and -31°C for 30 minutes, a time deemed sufficient to allow the clothing of the subject to equilibrate with the ambient environment. At the end of 15 mins and 30 mins. temperature and heart rate measurements were recorded. Then the subjects were told to walk at a speed of approximately two miles per hour over a set course so that at the end of 12 min, the subjects would be again at the starting area where heart rates and temperatures could be recorded. This procedure was repeated for a second time. After these readings, the subjects were instructed to traverse the course at approximately double the former speed. After 18 min of walking at this speed, temperatures and heart rates were again

recorded. A typical recording sheet is shown in Fig. 1.

Insulation values in clo units ($I_{clo} = .155\ (^{o}Cm^2/W)$ of the parkas were calculated according to the method used at the Laboratoire de Medecine Aerospatiale, France, by Boutelier (personal communication). In this method it is assumed that 74% of the individual's metabolic heat is lost through the clothing covering the body, arms, and legs. Thus, insulation of the parka can be calculated by:

$$I = \frac{\Delta T}{.74M}$$

where: I = insulation of the parka $((^{o}Cm^2)/w)$,

ΔT = the difference in temperature between the exterior surface and interior surface of the Parka at the abdominal region as measured by the thermistors,

and M = rate of heat loss per unit area (W/m^2)

$$\text{In clo units, } I_{clo} = \frac{6.45\ \Delta T}{.74M} = 8.72\ \frac{\Delta T}{M}$$

The metabolic rate of each subject was calculated from measurement of the individual's heart rate, based on a correlation between heart and metabolic rates that had previously been determined in a laboratory environment for each individual.(1)

RESULTS AND DISCUSSION

Since each subject traversed the course at slightly different speeds according to ground conditions, individual ability, variation in individual walking gait and parka worn, the results were recorded as insulation values compared to metabolic rates (Fig. 2). It can be seen that, under all conditions (standing, slow walk, and fast walk), the 74 parka provided greater insulation than the other parka types. The 51 parka was warmer than the 71 parka while the subject was at rest but soon fell to the same insulation value as the 71 parka during the walks. It is not surprising that the 71 parka was shown to have the least insulation since it is part of a "layer" system of clothing in which a combat jacket and liner should be worn under the parka. As this is customarily not done in practise in cold conditions, it was decided to test this parka as it is commonly used, a configuration that was expected to be of lesser benefit in keeping a subject warm.

From Table 1, it is evident that, for the same walking speed, the energy expenditure was greatest for the 74 parka. No difference

in energy expenditure was detected between the other two parka types. The 51 parka showed the greatest influence of air ventilation; its relative decline in clothing insulation was greatest of all the parka types when walking was performed by the subject wearing it. This decline in insulation was probably due to the short length of the 51 parka as compared to the others. Because of the increased ventilation during exercise, there was also a greater cooling of the abdominal region of the subject with the 51 parka even when compared with the 71 parka. (Table 2). This cooling is beneficial in cold environments in that it expedites the loss of the excess heat generated through exercise, thereby inhibiting sweating and the consequent loss of clothing insulation.

Surprisingly, even though the 74 parka was longer than the other parka types, it did not prevent the mid-thigh area from cooling (Table 2). In most cold weather clothing systems tested, there is usually a large difference in temperature between the mukluk and the lower part of the parka. It was observed that the 74 parka did not prevent this cooling when walking even though more subject energy expenditure (and consequently more heat generation) was required when wearing this parka than when wearing other parka types. The 74 parka, moreover, had a zipper which opened from the bottom of the jacket, but in these experiments it was tested in the closed position. (When the zipper was opened, air ventilation was increased and the bottom of the parka "flapped" in a manner which subjects found annoying.) In this configuration the extra length of the 74 parka did not provide more insulation in the thigh area, despite the fact that the extra length was the cause of increase energy expenditure and metabolic heat generation.

CONCLUSIONS

The 74 parka is a warm parka; however, its length increases energy expenditure for the same work performed relative to the others tested. Excess body heat is not eliminated as easily from it as from the 51 parka. It is suggested that his parka type be modified by decreasing its length.

REFERENCES

O'HARA, W.J. and ALLEN, C.L., Energy Expenditure Studies using ECG Telemetry during a Simulated Arctic Exercise: "Kool Stool I" DCIEM Technical Report No. 76-X-44.

TABLE 1

ENERGY EXPENDITURES DURING THE WALKS

PARKA	WALKING SPEED	ENERGY EXPENDITURE (WATTS)
74	Slow	230 ± 22
	Fast	492 ± 45
71	Slow	139 ± 14
	Fast	423 ± 67
51	Slow	170 ± 32
	Fast	398 ± 57

TABLE 2

FINAL ABDOMINAL AND THIGH TEMPERATURES AFTER THE FAST WALK
(APPROXIMATELY 4 M.P.H.)

PARKA	FINAL ABDOMEN TEMPERATURE (^{o}C)	CHANGE FROM INITIAL TEMPERATURE ^{o}C	FINAL THIGH TEMPERATURE (^{o}C)	CHANGE FROM INITIAL TEMPERATURE ^{o}C	NO. OF MAN-EXPERIMENTS
74	22.1 ± 2.9	(+1.6)	13.0 ± 1.0	(+0.3)	6
71	24.0 ± 2.3	(-3.4)	14.5 ± 1.3	(-4.5)	4
51	15.3 + 2.0	(-10.0)	13.5 ± 1.4	(-6.8)	4

KOOL STOOL II CLOTHING TRIALS

DATE ______________ LOCATION ______________

Clothing described overleaf, check ________
SUBJECT (No.) ____________ (__) OBSERVER(S) ___________

SKY _________ PRECIP __________ BLOWING SNOW __________

WALKING CONDITIONS _________________

TIME	SKED	ACT'Y	PLS	1	2	3	4	5	6	7	8	9	C1	C2	C3	CM	T_a	W	Ck
	15 m	STILL																	
	30																		1
	36	SLOW																	
	42																		2
	48																		
	54																		3
	57	FAST																	
	60																		
	63																		
	66																		
	69																		
	72																		4

Figure 1: Log Sheet used in recording data. Pulse ("PLS"), skin temperature (1-9), and the temperatures at various clothing interfaces (C1-C3) were measured at four check times. Weather conditions were also monitored throughout the test.

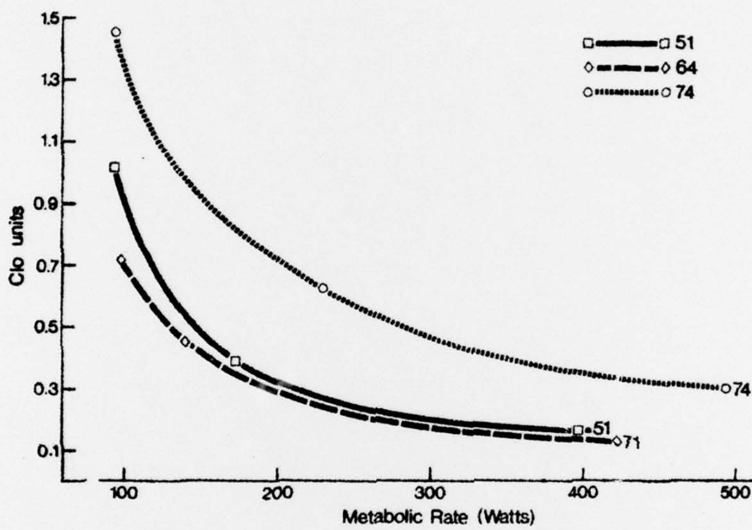

Figure 2: Parka insulation as a function of metabolic expenditure for three parka types (51, 71, and 74). The three points obtained for each parka correspond respectively to measurements made with subjects standing, walking slowly, and walking quickly. The different metabolic rates which apply to each walking speed reflect the metabolic costs imposed by the individual parkas on walking subjects.

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